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US 3572450 A US 2819039 A US 2730328 A
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(54) Deflection apparatus for directional drilling

(57) Deflection apparatus for use in directional boring comprises a housing 12 which is disposed about a drill string 14 and is rotatable relative thereto, a deflection member 42 pivotally connected to the housing 12 and moveable between a retracted position (not shown) adjacent the housing 12 and an extended position in which the member 42 is biased outwardly against the wall of the enlarged borehole 64 to deflect the drill string 14. A spring 28 maintains the member 42 in the retracted position and, when it is rotated past the equilibrium point by a floating piston, moves the member 42 into the extended position. The member 42 is locked in the extended position by locking means, such as spring fingers 94 which act through a collar 92 and engage in grooves in the housing 12.

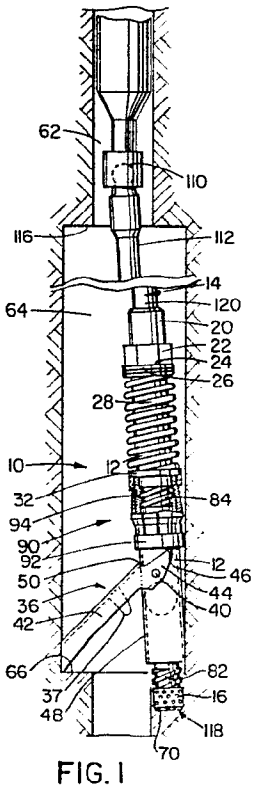

FIG. 1

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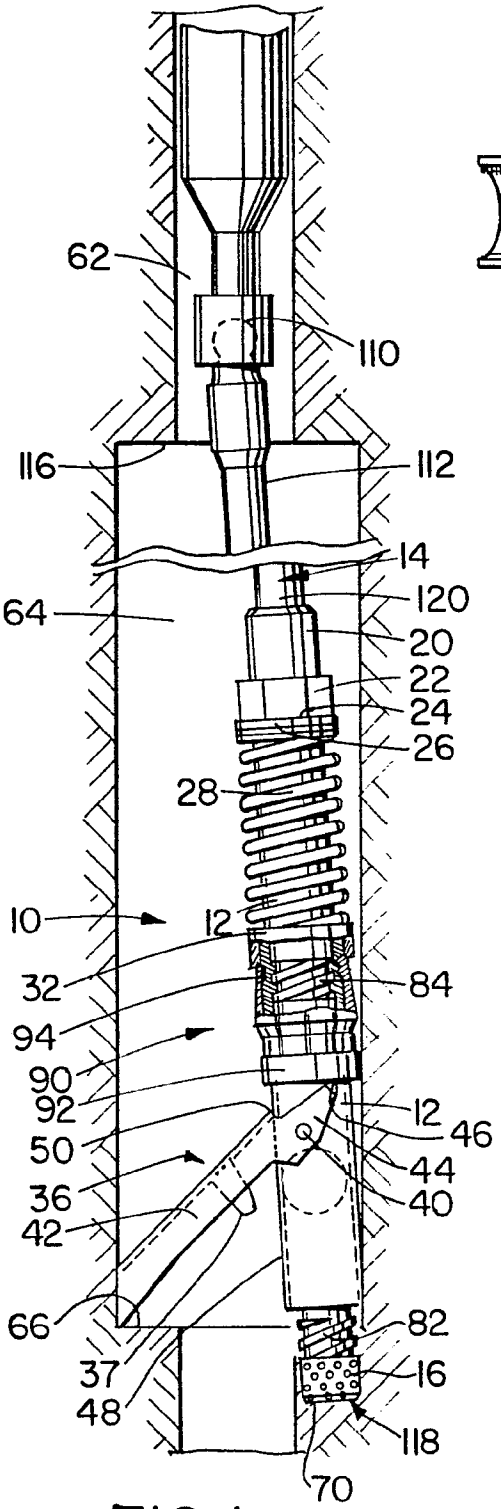


FIG. 1

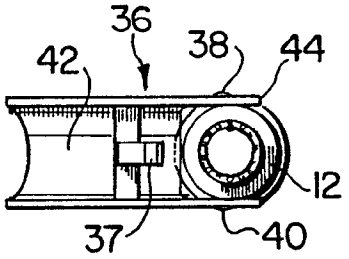


FIG. 3

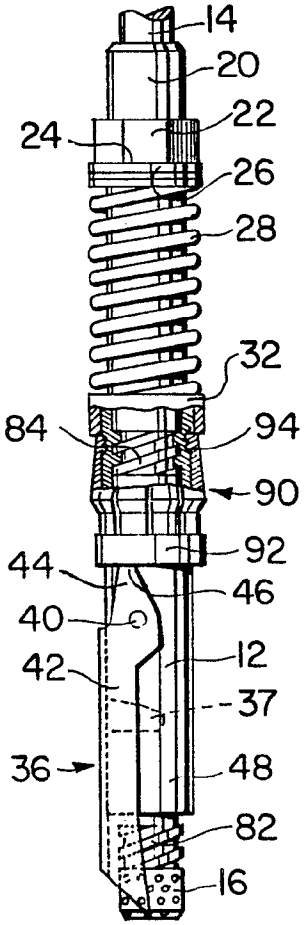


FIG. 2

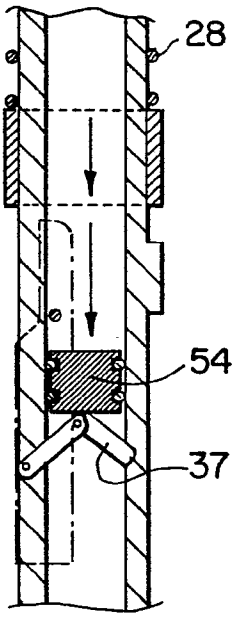


FIG. 4

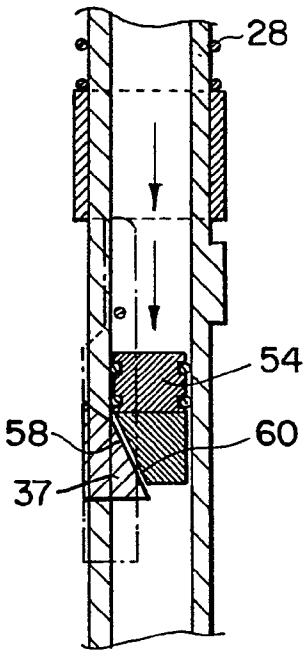


FIG. 5

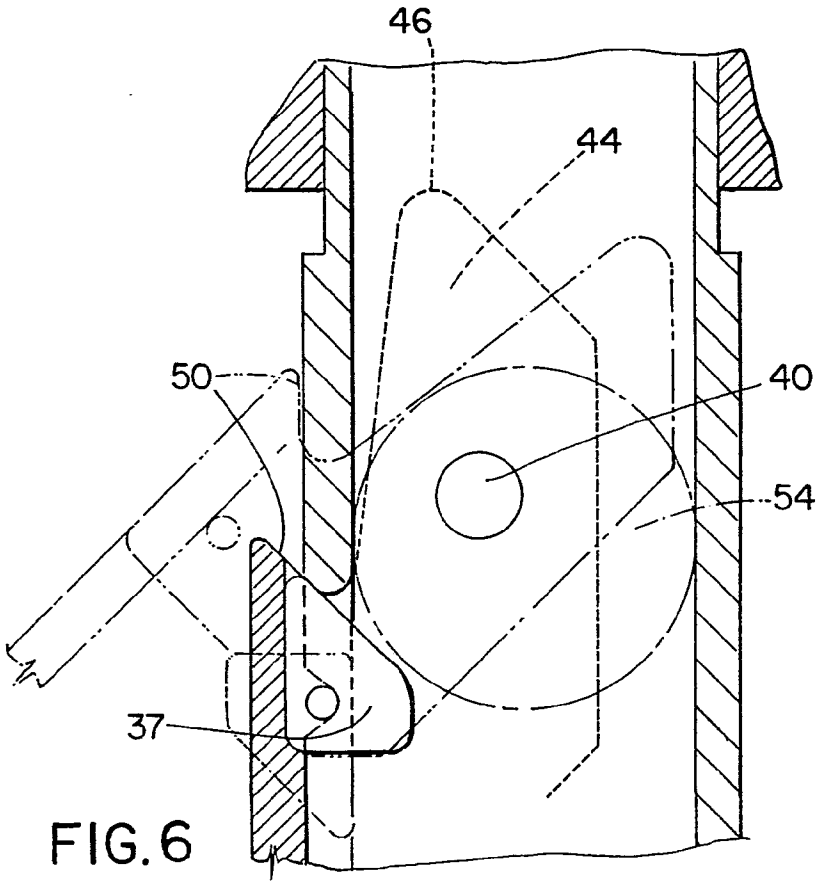


FIG. 6

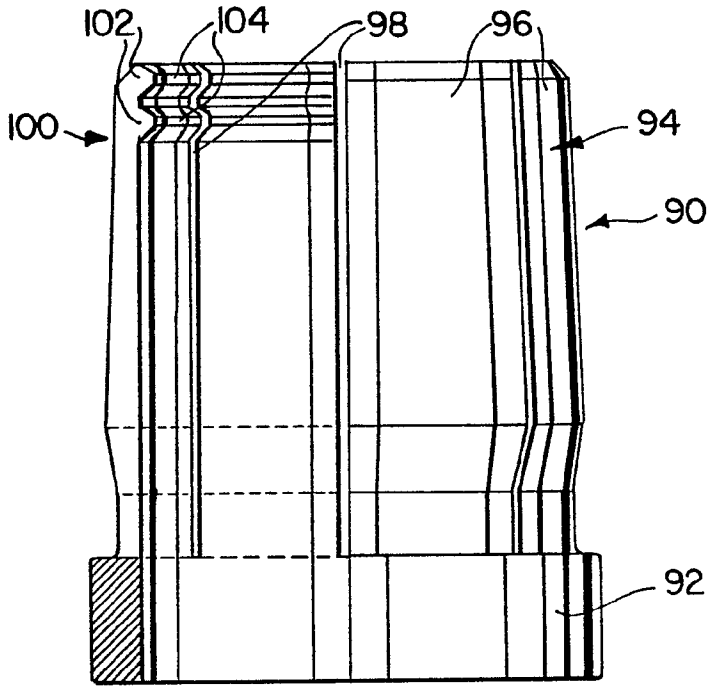


FIG. 7

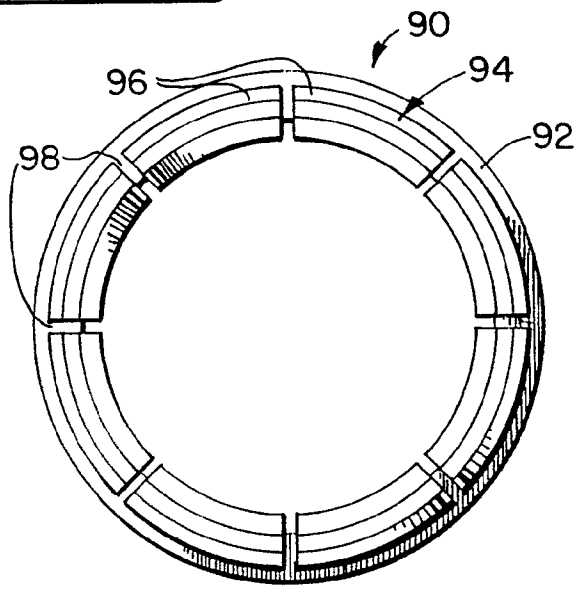


FIG. 8

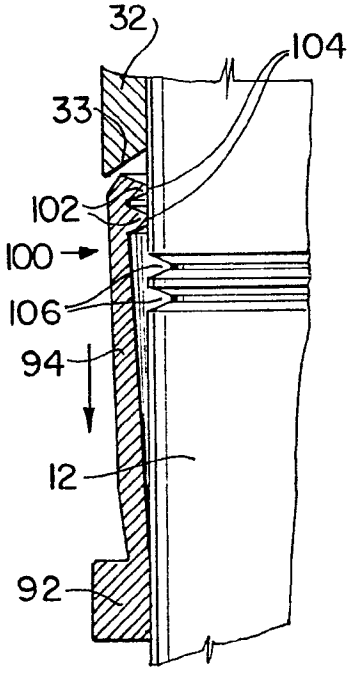


FIG. 9

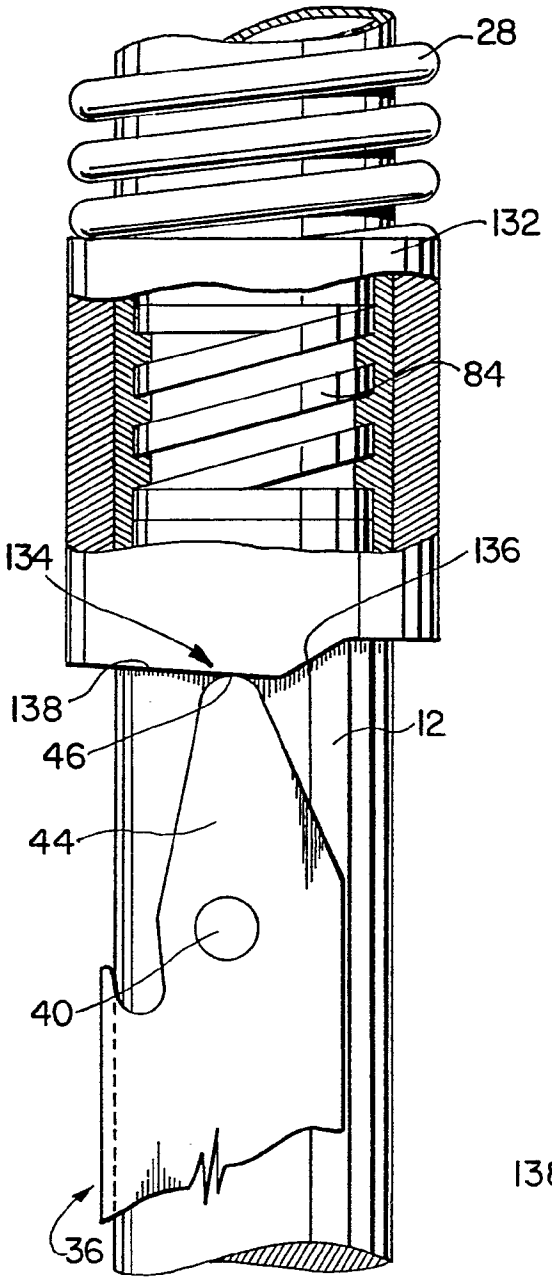
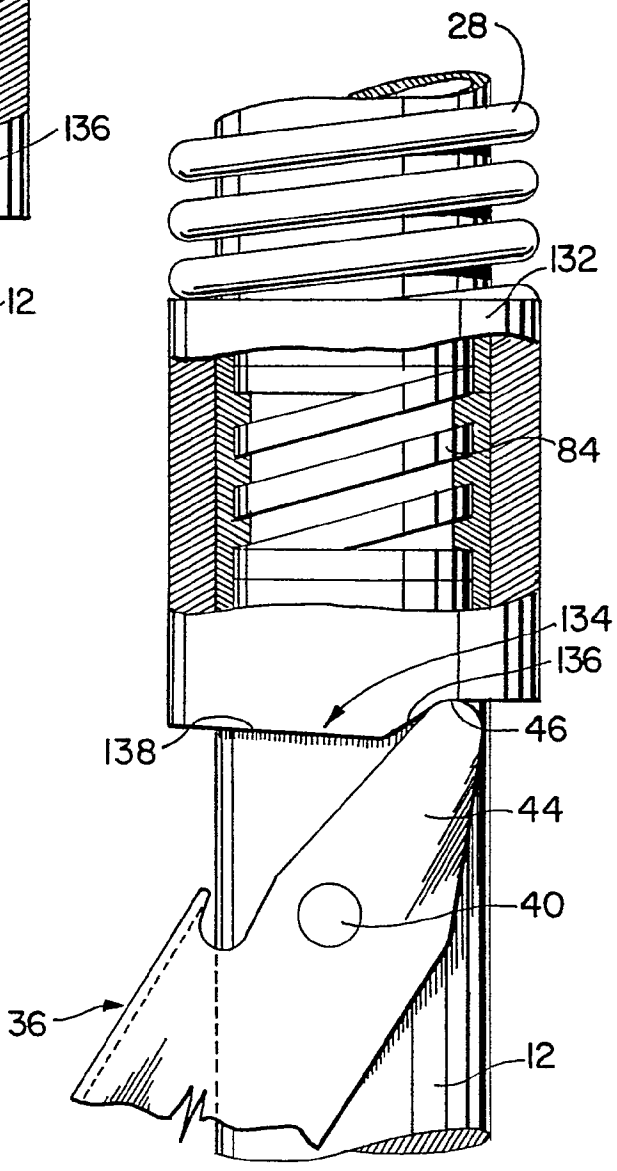

28
132
84
134
136
138
46
12
44
40
36

FIG. 10


28
132
84
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12

FIG. 11

DEFLECTION APPARATUS

This invention relates to deflection apparatus for use in deflecting a drill string for boring into the side of an existing borehole, and to a method for the use of such apparatus.

There are several instances where it is desirable to be able to deflect or control the direction of a new borehole in any desired direction and at any desired level out of the axis of an existing borehole. This may be to facilitate examination or production from a particular horizon after the borehole is drilled. For example, one important area where deflection may be required is in obtaining core samples, particularly continuous lateral samples, at various levels of an existing borehole. The absence of existing technology has made this last area generally impractical to date. Present technology for achieving these objectives suffers from serious shortcomings.

In general two methods have been utilized to achieve this deflection above the bottom of an existing hole. First, the whipstock method comprises the insertion into the borehole of wedges of various configurations which then deflect the drill bit in the desired direction. There are a substantial number of disadvantages to the use of the whipstock method. These include limitations on the bit styles and boring methods that can be used, primarily because of the contact of the bit with the durable surface of the whipstock, which wedges or jams the bit into the adjacent formation. Substantial extra time is required when using whipstocks, including extra trips into the hole to set and retrieve the whipstock.

The second method which has been utilized to obtain deflected or directional drilling is the use of a deployable member or element which is deployed adjacent the bit to press against the side of the hole to influence the bit to deflect while drilling at the bottom of a borehole. While these methods have provided some improvement, a number of substantial disadvantages remain. For example, in a number of these cases the deflection provided by the weight of the drill string on the bottom of the hole is a required element. In other cases the continued deployment of the deflection member or element is completely reliant on differential hydraulic pressure of the circulating drilling fluid.

Of substantial significance, earlier methods utilizing the deflection element deployment technique have generally been applicable to the bottom of the drill hole only. Furthermore, the deflection apparatus in these methods must move downhole with the bit and the drill string.

The present apparatus provides a deflection member or element which operates independently of drill string rotation and longitudinal movement and of fluid pressure in the drill string. It does not limit the type of bit to be utilized. The apparatus acts as an independent non-moveable anchor in the borehole allowing the drill string to pass through. It enables, for example, a sizable core sample to be obtained at any level of an existing borehole.

PRIOR ART

Canadian Patent 637,067, issued February 27, 1962, to Thompson, illustrates a typical whipstock deflection apparatus.

Canadian Patent 849,943, issued August 25, 1970, to Whipstock Inc. illustrates an apparatus having deployable elements utilized for straightening and stabilizing a borehole.

Canadian Patent 896,397, issued March 28, 1972, to Smith Industries International Inc., illustrates a deflection apparatus utilized with a non-rotating drill stem and wherein the deflection apparatus moves downwardly in the hole with the bit.

Other Canadian patents in the area are No. 1,122,965, issued May 4, 1982, to Conoco Inc. and 1,164,852, issued April 3, 1984, to Base.

United States patents in the area of interest are U.S. Patent 2,643,859 issued June 30, 1953, to Brown; U.S. Patent 2,730,328, issued January 10, 1956, to Brown; U.S. Patent 2,819,039, issued January 7, 1958, to Lindsay; U.S. Patent 3,045,767, issued July 24, 1962, to Klassen; U.S. Patent 3,129,776, issued April 21, 1964, to Mann; U.S. Patent 3,196,959, issued July 27, 1965, to Kammerer; U.S. Patent 3,298,449, issued January 17, 1967, to Bachman; and U.S. Patent 3,572,450, issued March 30, 1971, to Thompson.

Each of these U.S. patents illustrates one or more of the disadvantages to which reference was made above. Generally, deployment of deflecting elements is achieved by utilizing the hydraulic pressure of the drilling mud. Deflection is achieved in a number of cases by flexing of the drill string due to its weight where the bit is resting on the bottom of the drill hole. In all cases the deflecting apparatus travels downhole with the drill string and, at least in one case, the apparatus must be moved down the hole with the end part of the drill string on a step by step

basis, a very time consuming undertaking.

SUMMARY OF THE INVENTION

A deflecting apparatus has now been provided which alleviates several of the difficulties of the prior art. For example, once deployment of a deflection member is initiated, final deflection and maintaining of the deflection of the deflection member is achieved by spring action independent of position in the hole or of drilling mud circulation. Furthermore, the new apparatus can be positively anchored at any point in a borehole. The apparatus is independent of drill string movement and thus can maintain its position in the hole as the drill string moves downwardly. The apparatus thus continues to act at the same position in the hole against that section of the drill string which is passing through the apparatus at any time.

Accordingly, the invention provides a deflection apparatus for use in directional drilling comprising a housing which is adapted to be disposed about a drill string and to be rotatable relative to the drill string; a deflection member pivotally connected to the housing and moveable between a first equilibrium position in which the member is in a retracted position adjacent the housing and a second position in which the member is biased toward an extended position outwardly of the housing; means for maintaining the member in the first equilibrium position; means responsive to an external force for releasing the member from the equilibrium position; and means for biasing the deflection member into the extended position; and wherein the means for biasing is

responsive to the release of the deflection member from the first equilibrium position to move the deflection member toward the second position.

In a preferred embodiment the apparatus includes means for locking said deflection member in the extended position.

In a further embodiment of the invention the means for locking is moved from a first non-locked position to a second locked position responsive to the biasing means moving the deflection member to the extended position.

There is also provided a method of deflecting a drill string comprising: enlarging a section of a borehole; positioning a deflection apparatus on a lowest section of a drill string; lowering said apparatus to said enlarged section; deploying a deflection member to an extended position whereby to cause said apparatus to deflect in said enlarged section; and commencing boring.

In the accompanying drawings which illustrate embodiments of the invention:

FIGURE 1 illustrates the apparatus of the invention with the deflection member deployed in a borehole;

FIGURE 2 is a partially cut away elevation showing the deflection member in the retracted position;

FIGURE 3 is a cross-section through the apparatus at the deflection arm pivot point;

FIGURE 4 illustrates one manner of initiating deployment

of a deflection arm;

FIGURE 5 illustrates a second manner of initiating deployment of a deflection member;

FIGURE 6 illustrates a third manner of initiating deployment of a deflection member;

FIGURE 7 is a side view partially in section of a trip spring for use in the invention;

FIGURE 8 is a top end view of the spring of FIGURE 7;

FIGURE 9 illustrates the use of the trip spring of FIGURES 7 and 8;

FIGURE 10 is a partial section of a locking mechanism for use in the invention; and

FIGURE 11 is a partial section of the locking mechanism of FIGURE 10 in a different position.

While the invention will be described in conjunction with illustrated embodiments, it will be understood that it is not intended to limit the invention to such embodiments. On the contrary, it is intended to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

In the following description, similar features in the drawings have been given similar reference numerals.

The apparatus 10 comprises a housing 12 which is adapted to be positioned about a drill string 14. The housing 12 would in the usual case be located initially at the bottom of drill string

14 adjacent to the bit 16 and, for example, hung from bit 16 by a connecting arrangement to be described. When anchored in a borehole, housing 12 is axially rotatable relative to the drill string 14 and is in sealing contact with drill string 14 through bearings or bushings 18 (not shown) within the bushing flange 20.

A nut 22 is of greater diameter than the lower part of housing 12 and so provides an abutment or flange on the lower side 24 thereof. Nut 22 is in threaded engagement with housing 12 and so its position may be adjusted axially of housing 12. Below nut 22 is a collar 26.

A spring 28 is located about the housing 12 below collar 26 so as to abut against the lower side 24 of collar 26.

At the other end of spring 28 is a second collar 32 which is slidable along housing 12. The spring 28 is always in compression over the limits of movement of collar 32. The actual tension on the spring can be adjusted by adjusting the position of nut 22 along its threaded engagement with housing 12.

In one preferred embodiment, there is disposed below the second collar 32 and about housing 12 a generally cylindrical trip spring 90 (detailed in FIGURES 7, 8 and 9) comprising a lower collar 92 and an upper spring section 94.

Spring section 94 comprises a series of spring fingers 96 separated by slots 98. The spring fingers 96 are provided at the top 100 thereof with at least one and preferably two inwardly projecting tongues 102 having inner faces 104.

The trip spring 90 is slidable relative to the housing 12, with the tongues 102 pressing against housing 12 by virtue of spring fingers 96, and subject to the following. At a preselected

axial position the housing 12 is provided with a pair of circumferential grooves 106 corresponding to tongues 102 of trip spring 90. As will be discussed below, as trip spring 90 slides down along the housing 12, the tongues 102 will spring into the grooves 106 to lock the trip spring in position.

The bottom 33 of collar 32 is bevelled to aid in locking tongues 102 in grooves 106. The combination of spring 28, trip spring 90 and the action of the bevelled bottom 33 of collar 32 provide a predetermined locking force which must be overcome to release the trip spring once the tongues 102 and grooves 106 have engaged.

A deflection member 36 is pivotally attached to housing 12 by means of a pair of pivot pins 38 and 40. The deflection member 36 comprises a lower section 42 and upper extensions 44. As indicated in FIGURE 2, the deflection member 36 in the retracted position assumes a first equilibrium position in which force is applied to the top 46 of extensions 44 by the spring 28 acting through the collar 32 and the trip spring 90. In that position the force acts either through the pivot pins 38 and 40 or, if any moment is imposed about those pivot pins, it is to the left in FIGURE 2. In that situation the lower part 42 of member 36 brings up against the surface 48 of housing 12. Accordingly, in that first equilibrium position the deflection member 36 is restrained against rotation.

When apparatus 10 has been positioned in a borehole at the desired level, means such as the floating pistons illustrated in FIGURES 4, 5 and 6 are utilized to rotate the deflection member 36 out of the first equilibrium position illustrated in FIGURE 2

just to the point where a component of the force exerted by spring 28 on upper extension 44 of deflection member 36 is to the right, as shown in FIGURE 2, of the pivot pins 38 and 40. The spring 28 through the collar 32 and trip spring 90 will then force the deflection member into the extended position illustrated in FIGURE 1. The limit of the rotation of the deflection member 36 is defined by the position of grooves 106 in housing 12 and the cooperating tongues 102 of trip spring 90. The tongues 102 engage grooves 106 to lock the deflection member 36 in position. At the same time the profiled upper edge 50 of lower section 42 of deflection member 36 brings up against housing 12 to provide a positive limitation of rotation.

FIGURES 10 and 11 illustrate a further preferred means of locking the deflection member 36 in the extended position. The collar 32 and the trip spring 90 are replaced by an elongated collar 132 having a bottom edge 134 profiled to form a camming surface. The camming surface preferably comprises a first more steeply cammed area 136 and a second less steeply cammed area 138. These two surfaces will have opposite effects on the deflection member 36.

Thus, when the deflection member 36 is in the first equilibrium position (FIGURE 10), the cammed area 138 will tend to maintain the deflection member 36 in that first equilibrium position. Only a small amount of movement of collar 132 against spring 28 will allow the upper extension 44 of deflection member 36 to move to the right in FIGURE 10 out of the first equilibrium position. Such movement may be initiated as discussed below, preferably utilizing a floating piston technique. Deflection is

then completed by spring 28 acting on the upper extension 44 of deflection member 36 through elongated collar 132.

Once the deflection member 36 has been deployed, the top 46 of the extension 44 will have moved further to the right (FIGURE 11) and have passed over the steeply cammed area 136. The force of spring 28 combined with the steeply cammed area 136 will serve to lock the deflection member 36 in the deployed position.

As will be discussed later, the deflection member 36 must be at least partially returned to the first equilibrium position for removal from the hole. The radius of the top 46 of extension 44 of deflection member 36 and the radius or curvature of the steeply cammed area 136 are chosen such that a predetermined force exerted on the deployed deflection member 36 will overcome the locking action of the cammed surface and permit the deflection member 36 to rotate back toward the first equilibrium position.

While various techniques could be utilized to effect the initial rotation of the deflection member 36, the preferred technique is to utilize a piston slidable in the housing to act on an extension 37 of deflection member 36 which extends into the interior of the housing 12. As illustrated in FIGURE 4, the extension 37 comprises a hinged arm 52 which is caused to extend by the downward movement of a piston 54.

In FIGURE 5 the extension 37 is integral with or attached to the deflection member 36 and extends into the housing 12. Extension 37 is sloped at its side 58, and the piston 54 may have a correspondingly sloped side 60 or may have a conical bottom section to co-operate with the sloped side 58 of extension 37. Downward movement of piston 54 will then force the initial rotation

of deflection member 36.

In the preferred case the piston 54 is spherical, as illustrated in FIGURE 6.

The spherical piston or ball 54 is preferably placed inside housing 12 and above the extension 37 during assembly of the apparatus. This is essential in the preferred case, to be discussed, where a universal joint is utilized above the apparatus in the drill string.

The piston 54 is forced downwardly by hydraulic pressure when required to initiate deployment of member 36. To clear the housing 12 to make room for passage of the bit and core barrel, the piston is simply forced by the hydraulic pressure right out of the housing.

In order to facilitate the positioning of the apparatus in the borehole, a releasable connection is preferably provided between the lowest section of the drill string, above the bit 16, and the apparatus housing 12. One form of such connection is illustrated in FIGURE 1. The bottom section of the drill string 80 is provided with a coarse outer thread 82. The inside of the housing 12 is provided with corresponding internal threads 84. Threads 84 are for convenience positioned at the same level in housing 12 as trip spring 90. When the housing 12 is fitted down over the end section of the drill string and twisted in a clockwise direction relative to the drill string, the threads 82 engage threads 84. Once the apparatus 10 has been positioned at the proper level and in the desired direction in the hole and the deflection member 36 deployed, clockwise rotation of the drill string will remove threads 82 from threads 84 and the drill string

can then operate independently of the apparatus 10 in the downward direction.

When a sample has been obtained or drilling is completed, and the drill string withdrawn, the threads 82 will bring up against or re-engage the threads 84 to withdraw the apparatus 10 with the drill string.

As the apparatus 10 is withdrawn, and particularly as the deflection member 36 brings up against the shoulder 116 at the top of the enlarged area 64, the force exerted on the deflection member 36 will be sufficient to overcome the force of the spring 28 and whichever of the locking mechanisms is utilized. The deflection member 36 will thus be forced toward the initial retracted position of FIGURE 2 to allow the apparatus 10 to be readily withdrawn.

FIGURE 1 illustrates the apparatus of the invention in the preferred use situation for obtaining a core sample or deflecting a boring operation of another nature at an intermediate level of a pre-existing borehole. By known techniques a borehole 62 is preferably although not necessarily enlarged to form an enlarged area 64 including lower shoulder 66. As well, an enlarged area might occur naturally in the borehole. The apparatus 10 is lowered to the desired level and the deflection member 36 deployed as described above. The entire length of the deflection apparatus 10 is preferably within the enlarged area 64. The apparatus 10 and the contained drill string 14 are thus deflected into the position illustrated in FIGURE 1 with the axis of apparatus 10 and of the drill string at an angle to the axis of the hole. The bit 16 is preferably positioned on shoulder 66.

Typically, a continuous side hole core sample having

dimensions of 10 feet in length by 2 1/2 inches in diameter can be obtained in this manner commencing from a 7 7/8 inch diameter borehole. This is in contrast to current side hole coring procedures which typically yield small plug samples from the borehole wall having dimensions of about 1 inch by less than 1 inch.

It is highly preferred that the drill string be provided with a universal joint 110 above the lowermost section 112. This arrangement offers several advantages. First, it greatly facilitates obtaining a good angle of deflection.

Second, well defined axial and radial components of force are set up, the latter of which acts about the pivot pins 38 and 40, which function as a fulcrum to lever the apparatus 10 laterally toward the side of the borehole. This requires that the deflection member 36 be stabilized and selected locking mechanism performs this locking function.

The levering effect is enhanced by locating the pins 38 and 40 toward the bottom of housing 12.

The bottom section of the drill string 14 is made up of a coring barrel 118 and an extension section 120. Since the universal joint 110 cannot pass through the apparatus 10, the combined length of the coring barrel 118 and extension section 120 is chosen such that a sample of desired length can be obtained before universal joint 110 brings up against apparatus 10. It will be noted that the deflection angle will tend to increase as the universal joint 110 approaches the apparatus 10.

Typically the apparatus 10 may have an overall length of 4 to 5 feet, the enlarged area 64 of borehole 62 might extend over

a 10 foot length, and the combined length of coring barrel 118 and extension section 120; that is, the length from universal joint 110 to the bit 16, might be about 15 feet. Thus, prior to initiating the coring operation, the universal joint 110 will be located in the original borehole 62 above the enlarged area 64.

It is also preferred that the bottom 70 of the housing 12 be provided with teeth 72 (not shown) or similar gripping members to aid in stabilizing the apparatus 10 against rotation.

Once the apparatus 10 is positioned with the deflection member 36 deployed, the bit and drill string can move longitudinally relative to the anchored apparatus 10 to obtain a side tracking core sample or, as the case may be, to continue to drill an offsetting borehole.

It should be noted throughout that the deflection apparatus applies force to the drill string rather than to the bit to effect deflection.

CLAIMS:

1. A deflection apparatus for use in directional boring comprising:

a housing which is adapted to be disposed about a drill string and to be rotatable relative to said drill string and to be moveable longitudinally of said drill string;

a deflection member pivotally connected to said housing and moveable between a first equilibrium position in which said member is in a retracted position adjacent said housing and a second position in which said member is biased toward an extended position outwardly of said housing;

means for maintaining said member in said first equilibrium position;

means responsive to an external force for releasing said member from said equilibrium position; and

means for biasing said deflection member into said extended position;

wherein said means for biasing is responsive to said release of said deflection member from said first equilibrium position to move said deflection member toward said second position.

2. Apparatus as claimed in claim 1 and including means for locking said deflection member in said extended position.

3. Apparatus as claimed in claim 2, wherein said means for locking is moved from a first, non-locked position to a second, locked position responsive to said biasing means moving said deflection member to said extended position.

4. Apparatus as claimed in claim 1, 2 or 3, wherein said deflection member is an arm pivotally connected intermediate its ends to said housing, said ends comprising an upper and a lower end.

5. Apparatus as claimed in claim 4, wherein said means for maintaining said member in said first equilibrium position and said means for biasing comprise a coil spring disposed about said housing, said spring being adapted to act on said upper end of said deflection member, when in said first equilibrium position, to maintain said deflection member in said position and, when said deflection member has been moved out of said first equilibrium position, to act on said upper end of said deflection member to rotate said member about said pivotal connection to an extended position of said arm.

6. Apparatus as claimed in claim 5, wherein said spring is disposed between an upper collar coaxially disposed about said housing and a lower collar coaxially disposed about said housing, said lower collar being slidable longitudinally relative to said housing.

7. Apparatus as claimed in claim 6, wherein the position of said upper collar is adjustable longitudinally of said housing.

8. Apparatus as claimed in claim 7, wherein said collar is threadedly attached to said housing whereby said adjustment longitudinally of said housing is effected.

9. Apparatus as claimed in any preceding claim, wherein a bottom section of said housing is cut away on the side thereof opposite to said deflection member.

10. Apparatus as claimed in any preceding claim, wherein said housing has a bottom edge which is profiled to engage a formation through which drilling is to take place to thereby prevent rotation of said housing.

11. Apparatus as claimed in any preceding claim, wherein said means responsive to an external force comprises means extending from said deflection member into the interior of said housing and a piston in sealing slidable engagement with the interior of said housing, said piston, when forced downwardly in said housing by applied hydraulic pressure, acting on said means extending into said housing to rotate said deflection member out of said first equilibrium position.

12. Apparatus as claimed in claim 11, wherein said

means extending into said housing comprises an arm hinged intermediate its ends, connected at one end to said deflection member and having its other end abutting the inner surface of said houssing remote from said deflection member.

13. Apparatus as claimed in claim 11, wherein said piston is profiled longitudinally and wherein said means extending into said housing comprises a profiled member fixed at one side to said deflection member and adapted at the opposite side to interact with said piston to rotate said deflection member out of said first equilibrium position.

14. Apparatus as claimed in claim 12, wherein said piston is spherical.

15. Apparatus as claimed in any one of claims 5 to 8 as appendant to claim 2 or to claim 3, or in any one of claims 9 to 14 as appendant to any one of claims 5 to 8 as appendant to claim 2 or to claim 3, wherein said housing includes at least one circumferential groove between said coil spring and said deflection member, and wherein said means for locking comprises a trip spring disposed about said housing between said spring and said deflection member and slidable relative to said housing, said trip spring having at least one tongue disposed about an interior circumference thereof whereby said coil spring

acts on said trip spring to in turn act on said deflection member, such that when said coil spring moves said trip spring axially of said housing to move said deflection member to said extended position, said at least one tongue will engage said at least one groove to lock said deflection member in said extended position.

16. Apparatus as claimed in claim 15, wherein the length of said arm is chosen such that, when said at least one tongue engages said at least one groove to lock said deflection member in said extended position, said lower end of said deflection member will abut a sidewall in a borehole in which said apparatus is disposed and a sidewall of said housing remote from said deflection member will lie adjacent or will abut an opposite sidewall of said borehole.

17. Apparatus as claimed in claim 6, 7 or 8 as appendant to claim 2 or claim 3 or any one of claims 9 to 14 as appendant to claim 6 as appendant to claim 2 or claim 3, wherein said means for locking comprises a cammed surface on the bottom of said lower collar which, when said deflection member is in said extended position, acts on the end of said deflection member against return of said deflection member from said extended position.

18. A deflection apparatus for use in directional boring comprising in combination:

a) a lower drill string section adapted to be joined to an upper drill section by a universal joint, said lower drill string section including a coring barrel and an extension section; and

b) a deflection unit which is adapted to be disposed about a part of said lower section and comprising:

a housing which is adapted to be disposed about a drill string and to be rotatable relative to said drill string and to be moveable longitudinally of said drill string;

a deflection member pivotally connected to said housing and moveable between a first equilibrium position in which said member is in a retracted position adjacent said housing and a second position in which said member is biased toward an extended position outwardly of said housing;

means for maintaining said member in said first equilibrium position;

means responsive to an external force for releasing said member from said equilibrium position;

means for biasing said deflection member into said extended position; and

means for locking said deflection member in said extended position;

wherein said means for biasing is responsive to said release of said deflection member from said

first equilibrium position to move said deflection member toward said second position.

19. Apparatus as claimed in claim 1 and substantially as hereinbefore described.

20. Deflection apparatus substantially as hereinbefore described with reference to Figs. 1 to 3; Figs 4, 5 or 6; and Figs. 7 to 9 or Figs. 10 and 11 of the accompanying drawings.

21. A method of deflecting a drill string comprising:

enlarging a section of a borehole;

positioning a deflection apparatus on a lowest section of a drill string;

lowering said apparatus to said enlarged section;

deploying a deflection member to an extended position whereby to cause said apparatus to deflect in said enlarged section; and

commencing boring.

22. A method as claimed in claim 21 and including the step of securing said lowest section to said drill string by means of a universal joint.

23. A method as claimed in claim 21 or 22 and including the step of locking said deflection member in said extended position.

24. A method as claimed in claim 21, 22 or 23, wherein at least a portion of the bottom of said apparatus abuts against a lower side of said enlarged section of said hole.

25. A method as claimed in any one of claims 21 to 24 and comprising applying a spring force to effect said deploying and to aid in maintaining said member in a deployed position.

26. A method as claimed in any one of claims 21 to 25 and comprising as a further step locking said deflection member in said extended position.

27. A method as claimed in any one of claims 21 to 26 and comprising forcing a piston through said deflection apparatus whereby to act on said deflection member to initiate said deploying step.

28. A method as claimed in any one of claims 21 to 27 and comprising providing a spring in said deflection apparatus to act on said deflection member to complete said deploying step.

29. A method as claimed in claim 21 and substantially as herein described.

30. A method of deflecting a drill string substantially as hereinbefore described with reference to the accompanying drawings.

31. The features hereinbefore described, or their equivalent, in any novel, patentable selection.

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